SpectraLink
Wireless@work™

Deploying NetLink Wireless Telephones
Best Practices

White Paper

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1.0 Introduction

Wi-Fi telephony is the convergence of wireless voice and data applications using a common Wi-Fi wireless LAN. Wi-Fi telephony bridges traditional telecommunications, data communications, and mobile technologies. A Wi-Fi wireless telephone is a wireless LAN client device, using the same network technology as wireless laptops and PDAs, and sharing the same medium. A Wi-Fi wireless telephone is also functionally equivalent to a wired telephone, requiring configuration and management from the local enterprise telephone system. Lastly, a Wi-Fi wireless telephone is a mobile communication device that requires special considerations for continuous high-quality connections as the user moves throughout the coverage area.

SpectraLink pioneered the use of Wi-Fi telephones in a wide variety of applications and environments, making SpectraLink's NetLink Wireless Telephones the market-leading Wi-Fi telephone devices. This document identifies issues and solutions based on SpectraLink's extensive experience with Wi-Fi telephony.

1.1 Comparing Voice and Data

Voice and data applications have different attributes and network requirements. The most significant difference is their tolerance for network errors and delays. Whereas data applications are designed to accept just about any amount of packet delays and retransmissions, voice quality will suffer with just a few hundred milliseconds of delay or a very small percentage of lost packets. Data applications are typically bursty in terms of bandwidth utilization, while a telephone conversation utilizes a consistent, and relatively small, amount of network bandwidth.

1.2 Implementation Issues

Using a wireless LAN for voice is not complex, but there are some things that need to be considered, particularly for enterprise applications. A critical objective of deploying enterprise Wi-Fi telephony is to maintain similar voice quality, reliability, and functionality as users expect from their wired business telephones. The key issues in deploying Wi-Fi telephony are coverage, capacity, quality of service (QoS), telephone switch integration, and security. This white paper provides recommendations for ensuring that a network environment is optimal for SpectraLink's NetLink Wireless Telephones.

2.0 Wireless LAN Layout Considerations

NetLink Wireless Telephones utilize a Wi-Fi network consisting of wireless LAN access points (APs) distributed throughout an enterprise environment. The required number of APs is driven by two factors: coverage area and system capacity.

2.1 Coverage

One of the most critical issues in deploying NetLink Wireless Telephones is ensuring sufficient wireless coverage. Often enterprise Wi-Fi networks are designed only for data applications and may not provide adequate coverage for wireless telephone users. Quite often these networks are designed to cover only areas where data terminals will be used, and do not include coverage in other areas such as stairwells, bathrooms, building entrances, or lobby areas where NetLink handsets may be used.

The overall quality of coverage is also more important with telephony applications. Coverage that is suitable for data applications may not be adequate for Wi-Fi telephony. Most data communication protocols provide a mechanism for retransmission of lost or corrupted packets. Delays caused by retransmissions are not harmful, or even discernable, for most data applications. However, the real-time nature of a full-duplex telephone conversation requires that voice packets need to be received correctly within tens of milliseconds of their transmission. There is little time for retransmission; lost or corrupted packets must be discarded. In areas of poor coverage, data application performance may be acceptable due to retransmission protocols, but real-time voice quality may not be acceptable.

Another factor to consider in determining the coverage area is the device usage. Wireless telephone devices are used differently than wireless data terminals. Telephone users tend to walk as they talk, while data users are most often stationary. NetLink Wireless Telephones are usually held next to the user's head, introducing additional radio signal attenuation. Data terminals are usually set on a surface or held out at arms length so the user's body has little affect. Because of these factors, a wireless telephone may have less range than a data terminal and the wireless LAN layout should account for a general reduction in radio signal propagation.

2.1.1 Overlapping Coverage

To provide comprehensive coverage for Wi-Fi telephony applications, APs need to be positioned with sufficient overlapping coverage to ensure that there are no coverage gaps, or dead spots, between them. As NetLink Wireless Telephones move out of range of a particular AP, they seek out another AP to hand-off to, or re-associate with, in order to maintain their network connection. A properly designed Wi-Fi network will provide seamless hand-offs between APs, ensuring excellent voice quality throughout the facility.

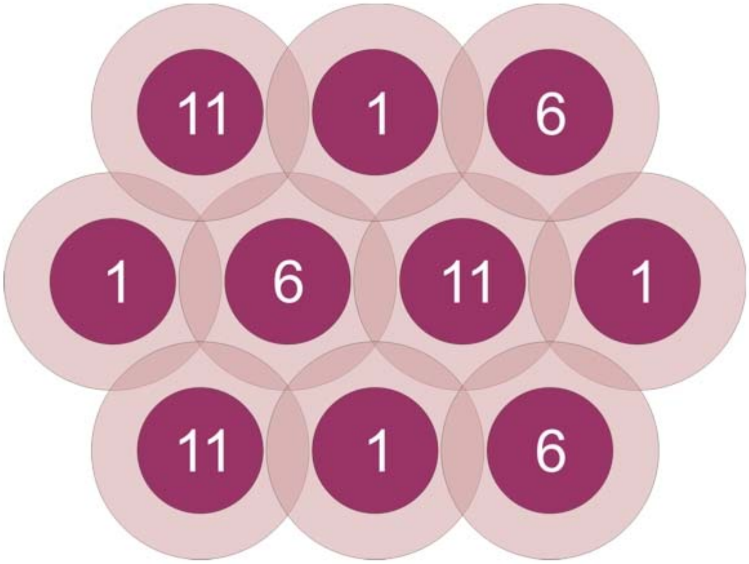
The wireless LAN layout must factor in the transmission settings that will be configured within the APs. The transmission of voice requires relatively low data rates and a small amount of bandwidth compared to other applications. The 802.11 standard includes data rate reduction specifications so that as a user moves away from the access point, the radio adapts and uses a less complex and slower mechanism to send the data. The result is increased range (coverage) when operating at reduced transmission rates. Access points should generally not be configured to limit the transmission to only the higher rates if wireless voice is an application on the wireless LAN because the coverage area of the AP will be greatly reduced. If a site requires configuring the APs to only negotiate at the higher rates, the layout of the wireless LAN must account for the reduced coverage and additional APs will be required to ensure seamless overlapping coverage at the higher rates.

2.1.2 Wireless Bridges

Wireless bridges are used to connect Ethernet LANs or extend the range of existing wireless LANs. Such devices generally create bottlenecks for network capacity and add delay to the overall network, which is not tolerable in the boundaries of QoS requirements. SpectraLink does not support a configuration that includes wireless bridges and does not recommend using wireless bridges within any wireless voice network.

2.2 Channel and Power Considerations

Adjacent APs need to use different radio channels to prevent interference between them. The 802.11b standard utilized by NetLink Wireless Telephones provides three non-interfering channels: channels 1, 6, and 11 for North America. Access points within range of each other should always be set to non-interfering channels to maximize the capacity and performance of a wireless LAN, as shown in the diagram below:



Non-interfering, Overlapping 802.11b Channel Coverage

The transmission power of APs can also be increased or decreased to provide more or less AP coverage area. Generally, the transmit power setting should be the same for all APs in a facility. This minimizes the chance of higher-power APs interfering with nearby lower-power APs, and provides consistent coverage.

2.2.1 Site Surveys

Performing a site survey can minimize the possibility of dead spots. The AP equipment provider can usually perform a site survey. While many tools exist that allow customers to perform their own assessment, SpectraLink recommends that every site employ a professional site survey to ensure optimum coverage and minimize interference.

Site surveys are a necessity for large or complex facilities. An extensive site survey will ensure that the minimum number of APs are deployed, but at the risk of having to significantly reconfigure the network if the coverage area is remodeled. Wi-Fi infrastructure providers are making significant developments to reduce the time, cost, and complexity of determining AP locations. Because the cost of APs has significantly dropped over the last few years, in some cases it is more cost effective to install more APs with overlapping coverage rather than try to maximize coverage for each AP with a rigorous site survey.

To verify coverage with an existing Wi-Fi network, NetLink Wireless Telephones offer a site survey mode that can be used to test the AP's signal strength in the wireless LAN coverage area. This mode detects the four strongest AP signals and displays the signal strength and the AP channel assignments. This mode can be used to detect areas with poor coverage or interfering channels. With the NetLink e340 and i640 Wireless Telephones, the entire coverage area should be checked to ensure that at least one access point's reading is stronger than –70 dBm in all areas. Also, if the site survey mode indicates 2 APs using the same channel, then at least one other AP must be indicated at 10 dBm stronger than those APs to avoid channel conflicts. After a site survey is completed, coverage issues can be resolved by adding and/or relocating APs and overlap issues may be resolved by reassigning channels or by relocating some access points. Another complete site survey should be performed after any adjustments are made to ensure that the changes are satisfactory and have not impacted other areas.

2.2.2 Access Point Data Rates and Power Output

All APs on the wireless network used by the NetLink Wireless Telephones must be set to the same supported and basic data rates. If this is not adhered to, the NetLink Wireless Telephones may not associate to the closest AP if a more distant one supports a higher data rate.

In addition, all APs must be set to operate at the same power output. SpectraLink highly recommends a power output setting of 100 mW. If this cannot be accommodated, SpectraLink recommends a 50 mW setting and requires a minimum of 30 mW. With lower power output settings, special attention must be made to AP placement to ensure there are no frequency re-use issues. These problems may not be evident when using the handset's site survey tool as it is assumes 100 mW transmission power from the APs.

2.3 Capacity

The network capacity requirements also factor into the number of APs required, although in most cases the coverage area is the primary factor. Data traffic is very bursty and sporadic, but data applications can tolerate network congestion with reduced throughput and slower response times. On the other hand, voice traffic cannot tolerate unpredictable delays, but at least the bandwidth requirements are constant and consistent for every phone call. Also, telephone traffic can be predicted using probabilistic usage models, allowing a network to be designed with high confidence in meeting anticipated voice capacity requirements. Beyond the normal IP telephony design guidelines, there are several additional considerations that need to be addressed for Wi-Fi telephony with NetLink Wireless Telephones.

2.3.1 Access Point Bandwidth Considerations

There are several factors that determine the AP bandwidth utilization of a telephone call. The first is the VoIP protocol used and its characteristics. The type of codec utilized combined with the packet rate will determine the size of the voice packets, along with any additional overhead information required for the protocol. The payload information makes up a little more than half of a typical voice packet, with 802.11 and IP protocol overhead filling the rest. The 802.11 protocols include timing gaps for collision avoidance, which means bandwidth utilization is more accurately quantified as a percentage rather than actual data throughput. The percentage of bandwidth used increases for lower data rates, but it is not a linear function because of the bandwidth consumed by the timing gaps and overhead. For example, a call using standard 64 kb/s voice encoding (G.711) utilizes about 4.5% of the AP bandwidth at 11 Mb/s, and about 12% at 2 Mb/s. In this example, four simultaneous calls on an AP would consume about 18% of the available bandwidth at 11 Mb/s or about 48% at 2 Mb/s.

The following table lists the theoretical percentage of available bandwidth used per telephone call for each 802.11b data rate:

	1 Mb/s	2 Mb/s	5.5 Mb/s	11 Mb/s
NetLink Telephony Gateway (24 kb/s), 20 ms sample rate	**15.7%**	**10.0%**	**6.4%**	**5.4%**
G.711 (64 kb/s), 30 ms sample rate	**20.5%**	**11.7%**	**6.1%**	**4.5%**
G.729 (8 kb/s), 30 ms sample rate	**9.3%**	**6.1%**	**4.1%**	**3.5%**

Theoretical Call Bandwidth Utilization of 802.11b Access Points

The maximum number of simultaneous telephone calls an AP can support is determined by dividing the total available bandwidth by the percentage of bandwidth used for each individual call. Approximately 20-40% of the AP bandwidth is reserved for channel negotiation and association algorithms, so 60-80% of the total available bandwidth should be used for calculating the maximum call capacity per AP. Lower overall bandwidth is available when there are a greater number of devices associated with an AP. For example if all calls on an AP are using a theoretical 4.5% of the bandwidth at 11 Mb/s, the actual number of calls expected at that rate would be about 13 (60% of bandwidth available / 4.5% theoretical bandwidth utilized per call). The actual number of calls expected at 2 Mb/s using the NetLink Telephony Gateway and a 20 ms sample rate is about 7 (70% of bandwidth available / 10% theoretical bandwidth utilized per call).

Even with all of the known variables, there are many other vendor-specific characteristics associated with individual access points that make it difficult to quantify the concurrent calls per AP without thoroughly testing specific configurations. As a general rule based on lab tests and experience, wireless LAN designs for NetLink Wireless Telephones should consider no more than 12 simultaneous calls at 11 Mb/s or no more than 7 calls at 2 Mb/s using either G.711 or NetLink Telephony Gateways. Using the G.729 codec will yield roughly 50% more calls at these mentioned data rates, but the general performance of NetLink Wireless Telephones using this codec on various APs has not been well tested.

To allow for bandwidth to be available for data traffic, SpectraLink provides the ability to limit the number of calls per access point within the NetLink Telephony Gateway and SVP Server. The “Calls per Access Point” setting will limit the number of active NetLink Wireless Telephone calls on each access point. Wireless Telephones are free to associate with other APs within range that have not reached the set maximum number of calls. SpectraLink recommends this setting be equal to or below the maximum number of calls discussed in the previous paragraph.

2.3.2 Push-to-Talk Multicasting Considerations

The push-to-talk (PTT) mode of the NetLink i640 Wireless Telephone uses SpectraLink's proprietary SpectraLink Radio Protocol (SRP) ADPCM encoding. If a PTT broadcast is active (i.e. a user presses the PTT button), the feature will use the bandwidth as indicated in the table above for the single transmitting i640 Wireless Telephone and one half of the bandwidth for all of the receiving i640 Wireless Telephones. The data rate used for PTT depends on the AP's settings for multicast traffic. This bandwidth used is independent of the number of handsets receiving the PTT call. Because the PTT mode uses IP multicasting, all APs on the subnet will transmit a PTT broadcast unless the network is running Internet Group Management Protocol (IGMP), in which case the broadcast will only go to those APs that are associated with NetLink i640 Wireless Telephones with the PTT feature enabled.

2.3.3 Telephone Usage

Because the data rate and the packet rate are constant, Wi-Fi telephony calls may be modeled in a manner very similar to circuit-switched calls. Telephone users (whether wired or wireless) generally tend to make calls at random times and of random durations. Because of this, mathematical models can be applied to calculate the probability of calls being blocked based on the number of call resources available.

Telephone usage is measured in units of Erlangs. One Erlang is equivalent to the traffic generated by a single telephone call that lasts for one hour. A typical office telephone user will generate 0.10 to 0.15 Erlangs of usage, which equates to six to nine minutes on the telephone during a one-hour period. Heavy telephone users may generate 0.20 to 0.30 Erlangs, or 12 to 18 minutes of phone usage in an hour. Note that traffic analysis is based on the aggregate traffic for all users, so users with higher or lower usage are averaged out.

The traffic engineering decision is a tradeoff between additional call resources and an increased probability of call blocking. Typical systems are designed to a blocking level (or grade of service) of 0.5% to 2% at the busiest times. Traffic model equations use the aggregate traffic load, number of users, and number of call resources to determine the blocking probability. The blocking probability can also be used along with the aggregate traffic load to determine the number of call resources required. Traffic model equations and calculators are available at www.erlang.com.

Consider a system with APs that can support six active telephone calls. If a blocking probability of 1% or less is desired, each AP can support about 13 moderate wireless telephones users. If the AP coverage can support 12 simultaneous calls per AP, each AP can support about 39 moderate users.

The following table shows maximum users per AP, based on the AP's ability to handle simultaneous calls:

User Calling Intensity	**Light**	**Moderate**	**Heavy**
Erlangs per User	0.10	0.15	0.20
Max Active Calls per AP	**Users Supported per AP (1% Blocking Probability)**		
1	1	1	1
2	2	2	2
3	4	3	3
4	8	6	4
5	13	9	7
6	19	13	10
7	25	17	13
8	31	21	16
9	37	25	19
10	44	30	22
11	51	34	26
12	58	39	29

Users Supported per Access Point

Areas where more Wireless Telephone usage is expected, such as cafeterias and auditoriums, can be provided with additional capacity to support more users by installing addition APs with smaller coverage areas. But for most enterprise applications, the number of calls supported within the coverage area of an AP should be sufficient.

3.0 Network Infrastructure Considerations

3.1 Physical Connections

The NetLink Wireless Telephone infrastructure components should connect to the facility's local area network (LAN) using Ethernet switches, as opposed to Ethernet hubs, to provide adequate bandwidth and limit traffic collisions.

Ethernet switches should be configured to negotiate the connection requirements automatically. NetLink Telephony Gateways require 10Base-T, half-duplex transmission and the NetLink SVP Server utilizes 10/100Base-T, half or full-duplex transmissions and can be set to automatically negotiate or be configured to a specific transmission configuration.

Network wiring is an important component of any Ethernet based system and is subject to local and state building code specifications. Category 5, 4-pair 10/100Base-T Ethernet cabling should be used for NetLink Wireless Telephone infrastructure equipment.

3.2 Assigning IP Addresses

NetLink Wireless Telephones operate as LAN client devices and therefore require IP addresses to work with the network. IP addresses can be assigned statically through the configuration menus on the handsets, or dynamically using standard DHCP protocol. For dynamic IP addressing, a DHCP server must be available.

NetLink Telephony Gateways and NetLink SVP Servers also require IP addresses and support either static or DHCP address assignment. When utilizing multiple NetLink SVP Servers with an IP telephony server, the master NetLink SVP server must be assigned a static IP address. When operating with an IP telephony server, the NetLink SVP Server also requires a range of IP addresses that covers the total number of Wireless Telephones supported by that NetLink SVP server. When a NetLink Wireless Telephone registers with the telephony server, one of the IP address within this range is used to communicate between the NetLink SVP Server and the telephony server. This IP address is used by the IP telephony server as an alias for the NetLink Wireless Telephone, but will not be equivalent to the handset's IP address that was either statically assigned or obtained from the DHCP server. The range of alias IP addresses must not be used within any DHCP range or cover the IP address used by any other device. In the case where multiple NetLink SVP Servers are used for added capacity, an exclusive range of IP addresses equivalent to the number of total users each NetLink SVP Server can support is required per NetLink SVP Server.

3.3 Software Updates Using TFTP

All NetLink components can be field-upgraded with new software to add features or capabilities and bug fixes. NetLink Wireless Telephones utilize a TFTP client to automatically download new code when available. NetLink Telephony Gateways have an integrated TFTP server to support Wireless Telephone and OAI Gateway software upgrades. For installations that do not use NetLink Telephony

Gateways, a separate TFTP server must be provided. Also, the NetLink SVP Server requires a separate TFTP server for software updates. The NetLink Telephony Gateway cannot be used as a TFTP server for the NetLink SVP Server code. NetLink Telephony Gateways receive software updates only through an FTP server.

4.0 Quality of Service

4.1 SpectraLink Voice Priority (SVP)

Quality of Service (QoS) is a means of guaranteeing a level of service that will result in a network connection of adequate quality. Typically this results in providing different levels of service for different applications, depending on their requirements. When data and voice are competing for bandwidth it is necessary to have a prioritization method that provides a controlled preference to voice packets. The initial 802.11 standards did not provide a practical QoS mechanism, so SpectraLink developed SpectraLink Voice Priority to allow real-time voice applications to coexist with data applications on a Wi-Fi network without compromising voice quality.

Voice quality is ensured on a shared network with SVP, a QoS mechanism for quality of service that is fully compatible with Wi-Fi networks. Adopted by the leading wireless LAN vendors, SVP guarantees audio quality in a shared voice and data network. Access points generally use random backoff intervals and require all types of traffic to contend for bandwidth with equal rights. Treating all traffic equally can cause significant delays to voice traffic. Modifying the AP behavior to recognize and prioritize voice packets increases the probability of better performance while continuing to treat asynchronous data packets normally. The two operations that comprise SVP in the AP, minimizing random backoff and priority queuing, require a packet filtering mechanism. Packet filtering requires recognizing the packet's protocol identifier, which for SpectraLink packets is registered protocol ID 119 for the SpectraLink Radio Protocol (SRP). The NetLink SVP Server also performs packet delivery timing in the link to the Wireless Telephones that is critical for ensuring seamless handoffs among APs and for enhanced battery management processes.

4.1.1 SVP-enabled Access Points

SVP-enabled APs are required for all NetLink Wireless Telephone installations, even if the wireless LAN is being used only for voice. SVP is required to ensure the timing and delivery of SpectraLink voice packets. Without a method of prioritization for voice packets, the lack of a controlled delivery method will result in poor audio quality, even with only voice devices on the network.

Information regarding APs that are compliant with SVP, or otherwise support a compatible voice QoS mechanism, can be found on SpectraLink's website in the NetLink product section at http://www.spectralink.com/products/svp.html. Configuration notes for specific AP models are also available on the website are should be closely followed to ensure the proper implementation of SVP.

4.1.2 SVP Infrastructure

To trigger SVP in the APs from the wired side of the network, a NetLink Telephony Gateway and/or NetLink SVP Server is required. NetLink Telephony Gateways can provide SVP support for small installations with four or fewer Gateways. If NetLink Telephony Gateways are used for SVP, the NetLink Wireless Telephones are limited to a maximum data transmission rate of 2 Mb/s.

A NetLink SVP Server is required for applications using an IP telephony server or using more than four NetLink Telephony Gateways. A NetLink SVP Server can also be used with four or fewer NetLink Telephony Gateways to allow a maximum data transmission rate of 11 Mb/s.

A single NetLink SVP Server supports 120 simultaneous calls when used with NetLink Telephony Gateways, or 80 simultaneous calls with an IP telephony server. Multiple NetLink SVP Servers can be used to increase capacity to support up to 850 total calls and 8,000 Wireless Telephones for IP telephony server interfaces. When used with NetLink Telephony Gateways, the total number of users is limited to 640 total users (40 NetLink Telephony Gateways). Refer to the NetLink SVP Server Installation, Setup, and Maintenance for more information about the maximum number of simultaneous calls and Wireless Telephones supported by multiple NetLink SVP Servers.

For installations with multiple NetLink SVP Servers, call resources are automatically allocated between the APs and the NetLink Wireless Telephones by those devices' MAC addresses. Allocation is done by dividing the MAC address by the number of NetLink SVP Servers and assigning the device based on the remainder. For example, if three NetLink SVP Servers are used, the first NetLink SVP Server is assigned to all APs and NetLink handsets with MAC addresses that are even multiples of three. The second NetLink SVP Server is assigned to MAC addresses with a remainder of one when divided by three, and the third is assigned to the MAC addresses with a remainder of two. In most instances, because of the large number of Wireless Telephones and APs expected in such an application, the distribution of call processing will be relatively even across all NetLink SVP Servers.

If a NetLink SVP Server other than the SVP Server assigned as the 'master' fails and can be no longer detected, the call processing will be automatically redistributed among the remaining servers. Some active calls may be lost during this process, but the process does not require any manual re-configuration. To minimize downtime related to a failed master NetLink SVP Server or a single server, a spare NetLink SVP Server can reside on the network and in the case of a failure, the network administrator can assign the IP address of the failed unit to the replacement SVP Server

5.0 Security

5.1 Security Concerns

Security provisions are critical for any enterprise Wi-Fi network. Wireless technology does not provide any physical barrier to the network, since radio waves penetrate walls and can be monitored and accessed from outside a facility. The extent of security measures utilized are typically proportional to the value of the information accessible on the network. The security risk for Wi-Fi telephony is not limited to the typical wired telephony concerns of eavesdropping on telephone calls or making unauthorized toll calls, but is equivalent to the security risk of the data network that connects to the APs. Several different security solutions can be implemented with NetLink Wireless Telephones. Determining the proper level of security should be based on identified risks, corporate policy, and an understanding of the pros and cons of the available security methods.

5.1.1 Wired Equivalent Privacy (WEP)

NetLink Wireless Telephones support Wired Equivalent Privacy (WEP) encryption as defined by the 802.11 standard. The handsets can use either 40-bit or 128-bit key lengths. WEP is intended to provide the same level of security over a wireless LAN as on a wired Ethernet LAN. Although security flaws have been identified, WEP still provides strong encryption that requires an experienced and dedicated hacker to break.

5.1.2 Cisco Fast Secure Roaming (FSR)

802.1x based authentication protocols such as EAP-TLS or Cisco's LEAP were developed to provide a higher level of security for wireless networks. These advanced methods require a back-end authentication server to authenticate users and generate new keys. This authentication and re-keying process can take up to several seconds and is required each time a user hands-off from one AP to the next in the same subnet. While this is taking place, the client device is not authenticated to an AP and there is an interruption in the data stream and therefore in the voice conversation. This interruption caused by the authentication process is unacceptable for voice communication in most enterprise applications.

To address the voice quality issues with most security mechanisms, SpectraLink and Cisco have worked together to deliver a Fast Secure Roaming (FSR) mechanism. FSR allows the authentication process to be done in a way that minimizes the number of messages required between the NetLink Wireless Telephones and the Cisco wireless LAN infrastructure. It is designed to be compatible with wireless standards and allow backward compatibility with devices utilizing previous security mechanisms, such as Cisco's LEAP.

Implementation of FSR for Cisco Aironet APs utilizes several standard and proprietary security components, including Cisco Client Key Management (CCKM), LEAP authentication, Michael message integrity check (MIC), and Temporal Key Integrity Protocol (TKIP). FSR not only addresses the roaming issue, but also provides strong security measures for authentication, privacy, and data integrity.

5.1.3 Emerging Security Standards

Recognizing the need for stronger security standards, the IEEE is developing the 802.11i standard, which is expected to be ratified in late 2004. The 802.11i standard includes stronger encryption, key management, and authentication mechanisms. An interim solution endorsed by the Wi-Fi Alliance is Wireless Protected Access (WPA), which is a subset of the 802.11i standard.

SpectraLink is committed to industry standards and will implement the 802.11i security standard once it is ratified. Depending on the required components of this standard, an enhanced security method that is conducive to mobile voice requirements, like the Cisco FSR mechanism, may be required to provide the best voice quality.

5.2 Utilizing VLANs

Virtual LANs (VLANs) can be used to segregate traffic into different security classes. By using separate VLANs, data traffic can utilize the most robust, but process intensive, security methods.

The 802.1Q standard establishes a method for inserting VLAN membership information into Ethernet frames via header information tags. NetLink infrastructure equipment and SpectraLink Voice Priority are not compatible with 802.1Q tags. The Ethernet switch must remove 802.1Q tags prior to forwarding packets destined for NetLink Telephony Gateways or a NetLink SVP Server. In other words, the Ethernet switch ports must not be configured as trunked ports.

5.3 MAC Filtering and Authentication

Access points can be configured to filter certain MAC addresses, which can be used as a method of securing the wireless LAN. This process generally works, but does cause some performance issues on some APs.

A more robust method of using MAC addresses to secure the network utilizes authentication back to a RADIUS server. In general, the delays caused by this authentication are not acceptable for voice traffic. Having the RADIUS server on the local network will help reduce delays, but the response time of the server may still be an issue. Adding any network delays will compound the issue. Network administrators should evaluate whether such delays are not great enough to affect the voice quality of NetLink Wireless Telephones.

5.4 Firewalls and Traffic Filtering

The traffic filtering capabilities of firewalls, Ethernet switches, and wireless switches can be used as security methods by allowing only certain types of traffic to pass onto specific areas of the LAN. To properly provide access control, it is necessary to understand the kind of IP traffic utilized by the NetLink Wireless Telephones.

When using NetLink Telephony Gateways to interface to a traditional PBX, the NetLink Wireless Telephones utilize the SpectraLink Radio Protocol (ID 119). This protocol in on a peer level with TCP and UDP and does not uses ports unique to TCP and UDP.

For an IP telephony server interface, the ports that are used depend on the IP telephony protocol used on the telephony switch interface. The telephony switch vendor should be able to supply the port numbers used by the protocol.

The NetLink Wireless Telephones, NetLink Telephony Gateways, and NetLink SVP Server use TCP and UDP and other common IP protocols from time to time. These include DHCP, DNS, WINS, TFTP, FTP, Telnet, ARP, and ICMP. SpectraLink uses proprietary UDP channels between the infrastructure components that use UDP ports 5454 - 5458. The push-to-talk (PTT) mode of the NetLink i640 Wireless Telephone uses the multicast IP address 224.0.1.116, which is also used by the NetLink Wireless Telephones and infrastructure components to locate and maintain each other.

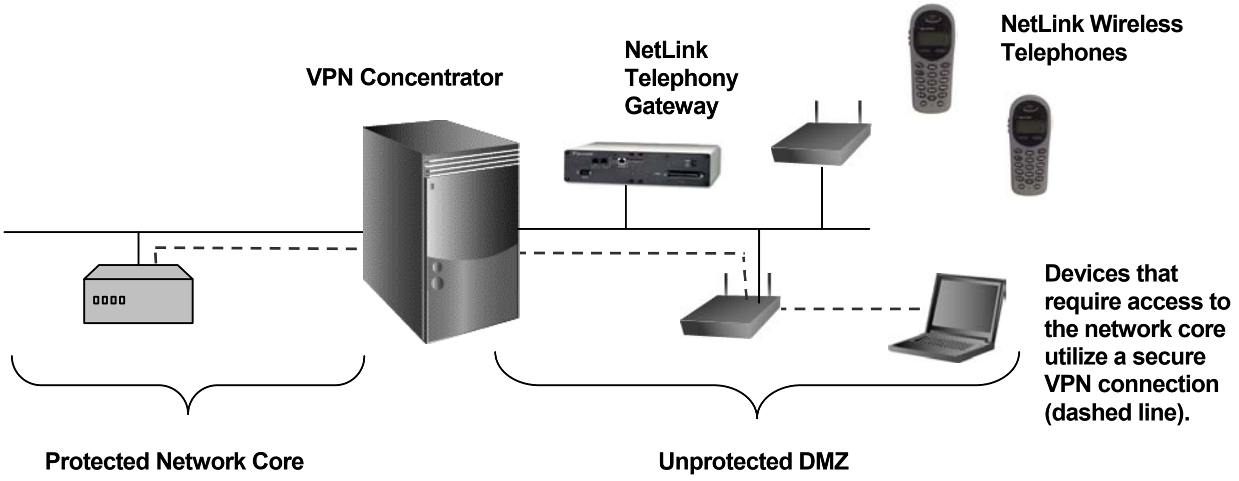
5.5 Virtual Private Networks (VPNs)

Virtual Private Networks are secured private network connections. VPNs typically employ some combination of encryption, digital certificates, strong user authentication and access control to provide security to the traffic they carry. They usually provide connectivity to many devices behind a VPN concentrator. The network can be broken into two portions, protected and unprotected:

1. The area behind the VPN server is referred to as the “protected” portion of the network. Sensitive, private network equipment such as file servers, email servers and databases would reside in this portion.
2. The area in front of the VPN server is referred to as the “unprotected” or demilitarized zone (DMZ), where the wireless APs and less sensitive network equipment may reside.

Utilizing VPNs can be an extremely effective method of securing a wireless network. Many customers have been implementing VPNs to maintain the integrity of their wireless LANs by requiring wireless users who need access to the protected portion of the network to connect through a firewall.

Voice devices, such as the NetLink Wireless Telephone do not require access to the protected portion of the network. Placing the NetLink Wireless Telephones, NetLink SVP Server(s), and NetLink Telephony Gateways in the demilitarized zone, and requiring data users to utilize the VPN ensures that the network is protected against hackers seeking to access sensitive information within the network core.


NetLink Wireless Telephones
NetLink Telephony Gateway
VPN Concentrator
Devices that require access to the network core utilize a secure VPN connection (dashed line).
Protected Network Core
Unprotected DMZ

Deploying NetLink Wireless Telephones with a VPN

6.0 NetLink Wireless Telephones and Subnets

Subnets are used to create a boundary between network segments. Although these boundaries are logical, they become somewhat of a physical boundary for mobile network devices moving throughout the enterprise. When a device with an established IP data stream (such as with an active phone call) attempts to roam across a subnet boundary, it needs to obtain a valid IP address within the new subnet. During this process the data stream cannot be re-established automatically and the connection (voice call) is dropped. In the case of the NetLink Wireless Telephones, the handsets should be power-cycled to obtain a new DHCP address. The handsets can automatically recover in the new subnet from a lost network connection with the original subnet, but the 40-second failure and recovery time generally warrants cycling the power.

Some APs, Ethernet switches, and third-party devices have implemented methods to facilitate device mobility. While these methods are transparent to the client device, they often cause enough delay and latency to manifest poor voice quality. In addition, many of these methods do not work well under loaded conditions, such as might be experienced with a large number of highly mobile wireless voice users.

NetLink Wireless Telephones must reside within the same subnet as the source of the SpectraLink Voice Priority (SVP) control. SVP can be controlled from a NetLink Telephony Gateway, a NetLink SVP Server, or a combination of the two. Because the NetLink SVP Server can only operate in a single PBX interface mode, Wireless Telephones cannot operate with a NetLink Telephony Gateway and in a native IP interface to an IP telephony server on the same NetLink SVP server. All SVP Servers on the same subnet must operate in the same PBX interface mode (either native IP or through NetLink Telephony Gateways).

There are additional subnet requirements for NetLink Wireless Telephones based on the infrastructure components that are used.

6.1 Subnets and NetLink Telephony Gateway Interfaces

NetLink Wireless Telephones, NetLink Telephony Gateways, NetLink SVP Server(s), and the wireless APs must reside on the same subnet. One reason for this requirement is that the NetLink Wireless Telephones use IP multicast messages to initialize the Wireless Telephone registration on the NetLink Telephony Gateways. Most routers deployed in multi-subnet Ethernet environments are configured to filter out multicast and broadcast messages. If a NetLink Wireless Telephone is powered up on a different subnet than the NetLink Telephony Gateway to which it is registered, the multicast message will never reach the NetLink Telephony Gateway.

6.2 Subnets and IP Telephony Server Interfaces

Although not recommended, NetLink Wireless Telephones can be deployed across multiple subnets when used with an IP telephony server interface. This can help facilitate subnet roaming when the subnets are geographically separated by defined boundaries.

Each subnet must have its own NetLink SVP Server. This is necessary because Ethernet packets containing voice as their payload have short interesting lifetimes, making the timely delivery of voice packets essential. Routers can introduce latency and delay between the NetLink SVP Server and the APs, which manifests as poor voice quality. Ethernet connectivity between the NetLink SVP Server and the IP telephony server should never exceed 100 ms of network delay and 10 ms of network jitter regardless of the physical properties of the link. The ability to cross a subnet boundary exists in this scenario, but the NetLink handsets will need to be power-cycled to obtain new IP address within the new subnet. In addition, other configuration considerations need to be addressed. Because users will not want to re-administer the Wireless Telephones to get them to work on another subnet, the ESSIDs should be broadcast using the “Learn Always” mode, the WEP key should be the same or turned off, and DHCP should be used.

7.0 Conclusion

Voice telephony over a wireless LAN represents the convergence of voice and data technology in the wireless environment. There are some specific network design criteria that must be applied to effectively implement a wireless telephony solution that is suitable for the demanding requirements of both voice users and data network administrators. With a little background study, both network and telephony professionals will be able to easily and confidently design and deploy a SpectraLink Wi-Fi telephony solution.